

THE GRANITE AREA OF THE SCHAPENBERG,
SOMERSET WEST.

(From the Geological Department, South African College.)

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(With Map; text-fig. 1.)

1. INTRODUCTION.

The following paper is the outcome of work undertaken on the suggestion of Dr. Rogers, Acting Director of the Geological Survey of the Union of South Africa, who, at the time the subject was mooted, kindly lent me the specimens which he had previously collected in the area, together with thin sections he had had prepared of several of them, for purposes of description. I wish to record my indebtedness to him for his kindness. So far as I am aware, the first—and only—published description of the granite of this area is a short paragraph occurring on p. 42 of the first edition of Dr. Rogers' "Geology of Cape Colony."*

To avoid confusion, the name Schapenberg is assumed, in this paper, to denote the whole of the rudely dome-shaped mountainous area occurring immediately to the east of Somerset West and north of the main road to Caledon.

On this assumption it includes metamorphosed sediments of the Malmesbury Series as well as rocks of igneous origin. The metamorphosed sediments form the high ground along the north-eastern side, and, in part, on the west, whilst granite constitutes the remainder. The Schapenberg thus defined rises steeply on the west, south and east—less steeply on the north and north-east—to a height of about 800 ft. above sea-level.

Streams rising in the central portion have eroded steep-sided ravines, thereby giving rise to mountainous spurs semi-detached from the central mass. On the south-western side there is the Water Kloof stream flowing in a south-westerly direction and dividing the two largest of such spurs. Another stream operating also in a south-westerly direction, and assisted

* This paragraph has been retained in the second edition of "Geology of Cape Colony," by Drs. A. W. Rogers and A. L. du Toit; see p. 32.

by one flowing north-west to join the Lourens River, has served to isolate a large hill composed of rocks of the Malmesbury Series, from the granite of the main mass. This hill is in the farm Morgen Ster.

Malmesbury Beds occupy the country immediately surrounding the Schapenberg. To the north-west of the latter area, and north of Somerset West, there is the eastern limit of the Kuils River granite, whilst to the east of the Schapenberg—and separated from it by only a narrow outcrop

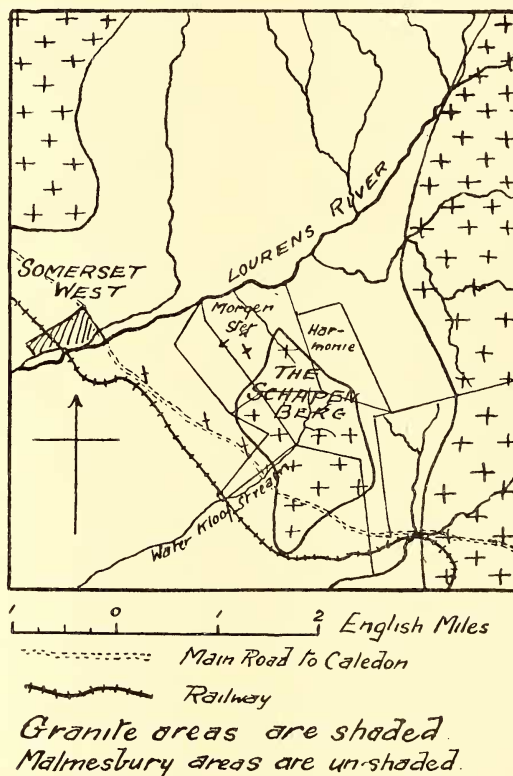


FIG 1.

of the Malmesbury Series—occurs the large granite mass extending from Sir Lowry's Pass to the Stellenbosch Mountains.

2. THE MALMESBURY SERIES.

Since the chief object of this paper is to describe the Schapenberg granite and its modifications, mention must be made—in order the more fully to achieve that object—of the nature of the rocks into which it has

been intruded. Unfortunately exposures, in places where one would expect the rocks to be least affected by the intrusion of the granite mass, are comparatively rare, and, almost invariably, they are much weathered. These rocks form the gently sloping ground to the south-west of the Schapenberg, which, when soil-covered, is generally under cultivation; uncultivated areas are, as a rule, found to be covered with gravel the fragments of which are dark brown, ferruginous grits.*

Several pits have been dug in this deposit at various places alongside the main road to Caledon which show that it attains a thickness of several feet. Along the top side of this road, between Somerset West and Water Kloof, there are two or three exposures—much weathered—of Malmesbury beds *in situ*. The rocks have a light yellowish-brown colour, dip almost vertically, and strike N.N.W.–S.S.E. They appear to be fine-grained, argillaceous grits.

Although rocks of this series form the north-eastern portion of the Schapenberg (comprising the farm Harmonie and small portions of Altona and Myrtle Grove), exposures of them *in situ* are hard to find. Along the junction of this series with the granite in this locality, and particularly that portion of it which is in Morgen Ster, isolated blocks—most probably *in situ*—were found; some are of hard blue-grey grit, resembling hornfels; others, presumably varieties richer in argillaceous material, are spotted and occasionally micaceous, and always much weathered; whilst others again are highly tourmalinised. Veins composed of quartz and tourmaline—the two frequently occurring in parallel bands—traverse the beds in this locality. One specimen of a grit breccia was found lying loose on the surface. Fuller descriptions of such of these rocks as were suitably fresh for the preparation from them of thin sections, are given below.

Mention has already been made of the hill in Morgen Ster, isolated from the granite mass. Here the beds are well exposed. The rocks appear to be extremely fine-grained, indurated grits. Towards the top of the hill they are very massive. Whereas the strike is very generally N.N.W.–S.S.E., the dip varies both in direction and amount. On the western side of the hill the beds appear to be almost vertical, whilst to the north and west they dip about 70° E.N.E. and W.S.W. respectively. Apparently the beds forming the hill are striking along an anticlinal axis of folding. On the eastern side of the hill, in the ravine, the junction with the granite occurs,

* Several views are held as to the meaning of the term grit. Harker's use of the term is for a sandstone in which the component grains are angular. Hatch and Rastall's nomenclature is based on the size of the grains—irrespective of their shape; they regard rocks in which the grains have diameters greater than 2.5 mm. as a grit. Geikie uses the term for a very coarse-grained sandstone; Judd for a coarse-grained, felspathic sandstone, in which the component grains are angular. In this paper Harker's use of the term has been adopted.

and the beds are, in part, spotted. Here the surface of the ground is covered with fragments of grit, spotted slate (much weathered) and granite, together with fragments of a quartz-tourmaline rock also from the granite area.

Descriptions of Thin Sections of Rocks of this Series.

141 W. Macro : A dark-coloured, banded rock, extremely fine-grained and containing numerous small white spots.

Micro : The rock is composed entirely of angular quartz grains and brown tourmaline. The spots are small aggregates of quartz grains, devoid of tourmaline.

138 W. Macro : A dark blue-grey rock ; fine-grained and compact.

Micro : In this section the rock is seen to be extremely fine-grained and spotted. The bulk of the rock is composed of angular quartz grains and biotite ; a little tourmaline is present. Under the high power the spots are seen to be composed chiefly of muscovite ; some of them, between crossed nicols, extinguish as one, others as two or more individuals. Enclosed in the muscovite are grains of a colourless mineral having both a lower refractive index and a lower bi-refringence than the mica ; the bi-refringence seems too high for either quartz or cordierite. The grains are too small to allow for testing in convergent polarised light. The mineral may be andalusite.

It is significant that in both these rocks there is no trace left of original argillaceous matrix. It is presumed that the much-weathered, spotted varieties are modifications of the more highly argillaceous beds of the series.

3. THE GRANITE OF THE SCHAPENBERG.

Extent of Outcrop and General Description.

The granite not only constitutes, but is almost continually exposed over, the major portion of the Schapenberg ; it extends also into the lower lying and partly cultivated area to the south. Here it is largely covered with either soil or gravel and only isolated exposures serve to show its extension. One such exposure occurs about 150 yards above the Caledon Road as one approaches Water Kloof from Somerset West ; a second occurs a little further on in the same direction, whilst at a point still further east, about three-quarters of a mile distant from where the Water Kloof stream crosses the road, the granite is exposed in the roadway. Just above the road at this place there are small quarries in the granite. All these are exposures of a medium-grained grey granite which is described in detail below. Further to the south, and just to the north of the railway line, there is a low, stony

kopje formed of an extreme modification of the granite. This exposure apparently marks the end of the southern extension of the granite outcrop. To the south lies a broad alluvial plain extending to the sea (False Bay). Although no actual continuity can be traced between these various exposures, they have been regarded as portions of a continuous mass and mapped as such; this is in accordance with the interpretation of the late Geological Commission of the Cape of Good Hope.* As a general rule the limit of the granite can only be inferred from the presence of grit fragments on the surface. The greatest length of the outcrop is from north to south and is approximately 2 miles. The greatest breadth, from east to west, is about $1\frac{1}{4}$ miles.

Generally speaking, the granite forms very rugged country. At the surface, and frequently to a great depth below, the rock is much decomposed, so that it is a difficult matter to procure unweathered specimens. Essentially the rock is a grey, porphyritic granite, of which two distinct kinds occur which differ only in texture; the one is medium-grained with phenocrysts of felspar and quartz; the other is fine-grained—microcrystalline—containing phenocrysts of quartz, felspar, and biotite, and should be regarded either as a quartz porphyry or, more correctly, granite-porphyry. Very commonly surfaces have a coarse, grit-like appearance and are frequently studded with the felspar and quartz phenocrysts. No regular disposition of the fine and medium-grained varieties with regard to the centre of the intrusion is apparent. Along portions of the margin—particularly on the north and north-east—the granite varies considerably both in texture and mineral composition. These variations are due in part to the contact with the sedimentary series, and in part to subsequent pneumatolytic action. Descriptions are given of these altered granites below. Veins of black tourmaline and veins consisting of parallel bands of quartz and tourmaline, traverse the granite throughout a large part of the area; they generally strike from about 10° N. of E. to 10° S. of W. In addition to these quartz-tourmaline veins numerous roughly spherical, dark-coloured patches varying from 1 in. to 2 in. in diameter, and composed largely of black tourmaline, occur throughout the fine-grained granite porphyry. Shear planes are occasionally encountered running in the same direction as the quartz-tourmaline veins; frequently—as, for example, on the summit of the spur to the east of Water Kloof ravine—the courses of these planes are marked by veins of milky quartz. In the locality cited above, on each side of the quartz veins is sheared granite traversed by numerous veinlets of milky quartz. The shearing has, apparently, only affected a narrow strip of granite. The erosion of Water Kloof most probably commenced along one of these planes. Three pits have been dug at intervals near to the bed of the stream. From

* Sheet 1, Cape Colony.

all of these sheared granite, resembling—on account of the complete pulverisation of the feldspars—a metamorphosed sediment rather than a metamorphosed igneous rock, has been thrown out. From the two upper ones fresh granite showing no signs whatever, in the hand specimen, of mechanical deformation, has been thrown out in addition.

Only one specimen of an inclusion of a fragment of the invaded series was found. This contains abundant, almost black mica, and is noticeably foliated. It resembles in general appearance many of such inclusions which occur so abundantly in the granite of the Cape Peninsula.

Detailed Description of the Medium-grained Porphyritic Granite.

Macroscopic Characters :

Constituent Minerals : Greyish-white feldspar and blue-grey quartz abundant ; somewhat bronzed biotite only sparingly present.

Structure : Porphyritic ; phenocrysts of greyish-white feldspar (many showing Carlsbad twinning) and blue-grey quartz. About 250 yards to the north of the quarries on the road to Caledon this character is accentuated by the feldspars being unusually large (some are $1\frac{3}{4}$ in. long and $\frac{3}{4}$ in. broad), and having proved more resistant to the action of the weather than the groundmass. The surface is studded with them and also with large quartz phenocrysts.

Specific gravity : 2.63 (the average of several determinations).

Microscopic Characters :

The Feldspar Phenocrysts :

A microscopic examination of such portions of the phenocrysts as occur in the rock-sections confirmed the assumption—based on the initial inspection of the hand-specimens—that they were essentially composed of a feldspar characterised by simple—Carlsbad—twinning. In addition, they are traversed by veinlets of a mineral which, though largely altered to a micaceous aggregate, shows obscure traces of lamellar twinning parallel to the 010 cleavage of the phenocrysts. The behaviour of some of the phenocrysts between crossed nicols led one to suspect the presence of a lamellar twin structure in them, and it was deemed necessary, for a complete specific determination of the mineral, to prepare specially thin sections from cleavage flakes. This was done. Sections prepared from basal cleavage flakes showed, between crossed nicols, a structure suggestive of anorthoclase ; areas of fine lamellar twinning—“cross-hatching”—pass without any sharp line of demarcation, into others free from twinning.

The average of several determinations of the extinction of the homogeneous portions with regard to the 010 cleavage was 15°

that of several determinations of the sum of the extinction angles of two adjacent striæ was 29° . Again, in sections prepared from 010 cleavage flakes, the average of several readings of the extinction angle with regard to the 001 cleavage was $5^{\circ} 30'$.

A comparison of the above values with the corresponding values recorded for microcline induces me to regard these phenocrysts as microcline perthitically intergrown with albite.

There are occasional inclusions of quartz and decomposed albite.

The Quartz Phenocrysts :

These show only a slight tendency to idiomorphism. Mineral inclusions are not common; occasionally biotite is included. Rows of extremely minute fluid and gaseous inclusions occur. The extinction is undulatory.

The Groundmass :

This is composed chiefly of microcline and quartz; soda-lime felspar and, sparingly, biotite and muscovite, occur. The muscovite appears to be almost wholly a secondary mineral formed from the microcline. Microcline occurs in abundance and shows a tendency to idiomorphism. Occasionally the marginal portions of individuals are an intergrowth of microcline and muscovite. The quartz contains numerous minute inclusions and occasionally inclusions of apatite, zircon, and biotite. The extinction is undulatory. The biotite, which is much altered, occurs as small, irregularly-shaped individuals. The soda-lime felspar is an acid variety—albite to albite oligoclase. The accessories apatite and zircon are only rarely met with.

Mention must be made of a mineral which occurs both as a phenocryst and in the groundmass. It has a pale-green colour, a form similar to that of a felspar, possesses at least one good cleavage, and is easily scratched with a knife-blade. In thin section it is seen to be a much decomposed mineral; the decomposition product is essentially an aggregate of minute flakes of muscovite. It contains in addition small needle-like crystals of a colourless mineral (sillimanite?). Between crossed nicols faint zoning is to be observed in some individuals; others exhibit faint traces of lamellar twinning. A section parallel to the cleavage showed simple twinning combined with lamellar twinning. For a long time I was in doubt as to whether this mineral was pinite pseudomorphous after cordierite, or a much decomposed soda-lime felspar. Now, however, I incline to the latter view and rather regard it as a phenocryst which existed previous to the growth of the microcline phenocrysts.

The Quartz- or Granite Porphyry.

The fine-grained granite porphyry does not differ in mineral composition from the medium-grained porphyritic granite. The chief differences are, firstly, that biotite occurs as an additional phenocryst; secondly, that the groundmass is microcrystalline; and, thirdly, that the granite porphyry is characterised by containing, throughout a large portion of its mass, the rudely spherical tourmalinised patches previously mentioned. The quartz phenocrysts show a distinct tendency to idiomorphism; the boundaries of individuals, however, are not straight linear ones, but irregular, indicating corrosion by the groundmass. Penetration of the groundmass along cracks is also shown. Mineral inclusions are not common; occasionally one finds biotite. Rows of extremely minute fluid and gaseous inclusions occur. The extinction is undulatory. In the majority of cases the mica phenocrysts have become almost opaque through decomposition; in some cases the opacity is almost certainly due to the inclusion of rutile needles and the subsequent formation of material resembling leucoxene. One supposed phenocryst, when examined in thin section, proved to be an aggregate of biotite and quartz. Apatite is occasionally found included in the biotite; zircon was not identified.

4. THE MODIFICATIONS OF THE GRANITE.

(1) *The Tourmalinised Patches.*—These occur not only in the normal granite porphyry, but occur also in some of the other modifications described below. Microscopic examination shows that, whilst some are composed of quartz, tourmaline, feldspar (much decomposed; generally microcline) and muscovite, in others the feldspar is either residual or has entirely disappeared; some, again, contain only quartz and tourmaline.

(2) *The Andalusite-bearing Varieties.*—The varieties described hereunder are exposed along the contact zone on the sides of the ravine in Morgen Ster—particularly that portion which has a N.W.—S.E. trend. They are characterised by containing spherical tourmalinised patches similar to those described as occurring in the granite porphyry. One common variety is a rock resembling the latter in texture but differing from it in containing muscovite and andalusite. Varieties occur—according as the proportion of muscovite increases (both the feldspar and the andalusite become converted into muscovite) and that of the feldspar decreases, between this and one composed of quartz and muscovite and, in patches, tourmaline. To the last-named variety the term greissen could well be applied.

Mention must be made here of a specimen (labelled 73, S. end of Harmonie) collected by Dr. Rogers. The bulk of it is composed of a lavender-grey mineral with a prismatic habit and a fairly good cleavage. Muscovite and patches of black tourmaline (enclosing prisms of the grey material) also occur. Under the microscope the lavender-grey mineral is seen to be anda-

lusite; it is markedly idiomorphic. The tourmaline and the mica occur interstitially—enclosing the prisms of andalusite in a similar manner to that in which augite encloses the felspar in ophitic structure. The andalusite is quite fresh and shows its characteristic pleochroism—in some cases in irregular patches; in others zonally. No quartz was present in the section examined.

(3) *Greissen*.—The rocks which are here styled greissen occur along the north-eastern margin and at the extreme south of the granite area. They consist essentially of quartz and muscovite; some contain a little much decomposed felspar. All are characterised in the field by their platy structure. The bands vary in width from one, to two or three feet. They are either steeply inclined or vertical, and strike E.N.E.–W.S.W.—that is, in the same general direction as the quartz-tourmaline veins and the shear planes which traverse the area.

One specimen was obtained composed—except for just a little tourmaline in one portion—of light blue-grey quartz. On account of its fine, even-grained texture it has the appearance of a quartzite. Inset, however, are larger individuals of somewhat darker blue-grey quartz resembling the quartz phenocrysts of the granite porphyry. Since the specimen was obtained from a small vein-like outcrop—very probably a platy band—the rock might be regarded as belonging to this series.

Quartz-mica rocks, similar to those above described, have been recorded—(1) by Mr. A. Harker,* from Grainsgill, in the Carrock Fell district, Cumberland; and (2) from the granite area of Foxdale, I. of Man, by Mr. W. C. Simmons.†

Mr. Harker, in his description of the Grainsgill greissen, expresses the view that the mica is original.‡ Discussing its mode of origin he writes:§ “Regarding it as a modification of the granite, we see that, apart from subsequent chemical transformations, it must be due in the first place to some process of differentiation. . . . The cause of this differentiation was probably that advocated by Mr. Barrow in the case of his pegmatites, namely, mechanical force acting on the granite magma when crystallisation had already proceeded to a certain stage.” The same author refers to the granite of Foxdale, I. of Man, as follows:|| “This rock, already intruded among Skiddaw slates . . . consists of quartz, microcline, an acid plagioclase, muscovite, subordinate biotite, and little crystals of garnet and zircon. In the marginal part of the intrusion are developed bands and masses of pegmatite, thick veins and bands of greissen, and finally quartz-veins containing only local aggregations of white mica or bordered by a narrow seam rich in that mineral.”

* ‘Quart. Journ. Geol. Soc.,’ vol. li, No. 202, p. 139.

† ‘Geol. Mag.,’ No. 566, August, 1911.

‡ *Loc. cit.*, p. 141.

§ *Loc. cit.*, p. 144.

|| *Loc. cit.*, p. 143.

The above description of the Foxdale granite would serve also as a general description of the granites occurring to the east and west of the Schapenberg.

It would appear that the view—quoted above—as to the possible cause of the modification which gave rise to the Grainsgill greissen is applicable to these rocks of the Schapenberg area. In support of which view I would emphasize the following comparisons:—

- (1) Both are most probably correctly considered to be apophyses of a fairly acid type of biotite granite. The trend of the tongue-like, eastern extension of the Kuil's River granite, and the coincident direction of the axis of the folding observed in the Malmesbury Series to the west of the Schapenberg are, I believe, facts in support of this view with regard to the latter area.
- (2) In the case of the Grainsgill greissen, magmatic differentiation and mechanical force are considered to be controlling factors. Evidence is not lacking that such have been effective in the Schapenberg area; the existence of shear planes and the increasing acidity of the various rock-types described being considered as such.

5. CONCLUSIONS.

- (1) The granite intrusion of the Schapenberg is a composite one.
- (2) That there were three well-defined periods at which intrusion of magma took place.
- (3) That these periods of intrusion are represented, respectively, by the different rock types described.
- (4) That the order of intrusion was as follows:—
 - (a) Medium-grained porphyritic granite.
 - (b) Fine-grained granite—or quartz-porphyry; andalusite—bearing near its contact with the beds of the Malmesbury Series. It is questionable whether pneumatolytic action commenced to be effective during this period.
 - (c) The greissen. This period was in all probability one of great mechanical disturbance affecting the whole area. Intrusion took place along shear planes. Pneumatolytic action became effective throughout the whole area—along the shear planes in the porphyritic granite, giving rise to the quartz-tourmaline veins; along shear planes and throughout the quartz—or granite-porphyry—during this period.

The veins of white quartz, also occurring along shear planes, may be similar to those described by Mr. Simmons in his paper on the granite mass of Foxdale.* They were probably the last rocks to be formed in the Schapenberg area.

* *Loc. cit.*